THE
Marquis of Worceſter's
CENTURY
OF
INVENTIONS:

To which is added, An

APPENDIX;

CONTAINING

An Hiſtorical Account

OF THE

FIRE-ENGINE

For Raiſing WATER;

Which INVENTION originated from the above Work.

BY JOHN BUDDLE.

NEWCASTLE:
Printed and ſold by T. SLACK; and by
G. ROBINSON, Pater-noſter-Row.
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PREFACE.

TO the original edition of this little work, here preſented to the public, we ſtand indebted for the Fire-Engine, *the moſt valuable machine ever yet invented for the purpoſe of draining mines; and which may, without much impropriety, be called the* primum mobile *of the coal-trade.*

The firſt, and only edition of this work, being extremely ſcarce, on account of the bulk of the impreſſion being made a burnt-offering *to the diſingenuous principles and ſiniſter views of* Captain Savery, *who wanted to* pirate *the invention; yet the few copies ſtill remaining, with the greateſt certainty point out the* Marquis of Worcester *to have been the original author of that incomparable machine the Fire-Engine; to whoſe memory, therefore, not only the gentlemen of the coal-trade, but the whole nation, owe a tribute of gratitude for his great mechanical acumen and ſagacity; more eſpecially at this time, when nine collieries out of ten in the northern counties could not be wrought without theſe machines: And the editor hopes to ſtand excuſed, at the bar of the public, for offering a new edition of a work to which ſo much is owing.*

'Tis curious enough to obſerve by what ſlow gradations this machine has arrived at its preſent ſtate; the moſt capital improvements hitherto made thereon ariſing more from accidental occurrences and mere chance, than being the reſult of philoſophical theory: But as the principles of mechanics are now more generally underſtood, than they were fifty or ſixty years ago, we may hope ſoon to ſee the FIRE-ENGINE *in a more improved ſtate.——The very great depths to which winnings are now extended, and the large quantities of water required to be drawn, urge the neceſſity of the moſt careful ſcrutiny into the philoſophical principles, and the ſtructure and combination of the ſeveral component parts of this machine, in order to its being conſtructed with powers adequate to the deſired effect, and at a fair and regular expence.*

KYO, *near* LANCHESTER,
June 18, 1778.

ERRATA in APPENDIX.

Page 43, line 9 from bottom, for *Sum ſit* read *Sumſit*.
44, line 9 from top, for *amaſiſſe* read *amiſiſſe*.
44, line 11, from top, for *vaporum* read *vaporem*.

☞ The Reader will pleaſe to correct the three ſucceſſive Folios from p. 45 to p. 48, which thro' inadvertency are wrong numbered.

A

CENTURY

OF THE

Names and Scantlings

OF SUCH

INVENTIONS,

As at preſent I can call to mind to have tried and perfected; which (my former notes being loſt) I have, at the inſtance of a powerful friend, endeavoured, now in the year 1655, to ſet theſe down in ſuch a way as may ſufficiently inſtruct me to put any of them in practice.

———*Artis et Naturæ Proles.*

LONDON:
Printed by J. Griſmond, in the Year 1663.

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To the King's moſt excellent Majeſty.

S I R,

SCIRE *meū nihil eſt, niſi me ſcire hoc ſciat alter*, ſaith the poet, and I moſt juſtly in order to your Majeſty, whoſe ſatisfaction is my happineſs, and whom to ſerve is my only aime, placing therein my *ſummum bonum* in this world: Be therefore pleaſed to caſt your gracious eye over this ſummary collection, and then to pick and chooſe. I confeſs, I made it but for the ſuperficial ſatisfaction of a friend's curioſity, according as it is ſet downe; and if it might now ſerve to give aime to your Majeſty how to make uſe of my poor endeavours, it would crown my thoughts, who am neither covetous nor ambitious, but of deſerving your Majeſty's favour upon my own coſt and charges; yet, according to the old Engliſh proverb, *It is a poor dog not worth whiſtling after*. Let but your Majeſty approve, and

I will effectually perform to the height of my undertaking: Vouchſafe but to command, and with my life and fortune I ſhall chearfully obey; and *maugre* envy, ignorance, and malice, ever appear

Your Majeſty's paſſionately-devoted,
or otherwiſe diſintereſted Subject
and Servant,

WORCESTER.

To the Right Honourable the Lords Spiritual and Temporal; and to the Knights, Citizens, and Burgeſſes, of the Honourable Houſe of Commons, now aſſembled in Parliament.

My Lords and Gentlemen,

BE not ſtartled if I addreſs to all and every of you, this *Century* of ſummary heads of wonderful things, even after the dedication of them to his moſt excellent Majeſty, ſince it is with his moſt gracious and particular conſent, as well as indeed no ways derogating from my duty to his ſacred ſelf, but rather in further order unto it, ſince your Lordſhips, who are his great council, and you, gentlemen, his whole kingdom's repreſentatives, (moſt worthy welcome unto him) may fitly receive into your wiſe and ſerious conſiderations, what doth or may publicly concern both his Majeſty and his tender-beloved people.

Pardon me, if I ſay, my Lords and Gentlemen, that it is jointly your parts to digeſt to his hand theſe enſuing particulars, fitting them to his palate, and ordering how to reduce them into practice, in a way uſeful and beneficial both to his Majeſty and his kingdom.

NEITHER do I eſteem it leſs proper for me to preſent them to you in order to his Majeſty's ſervice, than it is to give into the hands of a faithful and provident ſteward whatſoever dainties and proviſions are intended for the maſter's diet; the knowing and faithful ſteward being beſt able to make uſe thereof to his maſter's contentment and greateſt profit, keeping for the morrow whatever ſhould be overplus or needleſs for the preſent day, or at leaſt to ſave ſomething elſe in lieu thereof. In a word, my Lords and Gentlemen, I humbly conceive this *ſimile* not improper, ſince you are his Majeſty's provident ſtewards, into whoſe hands I commit myſelf, with all properties fit to obey you; that is to ſay, with an heart harbouring no ambition, but an endleſs aim to ſerve my king and country: And if my endeavours prove effectual, (as I am confident they will) his Majeſty ſhall not only become rich, but his people likewiſe, as treaſurers unto him; and his peerleſs Majeſty, our king, ſhall become both beloved at home, and feared abroad; deeming the riches of a king to conſiſt in the plenty enjoyed by his people.

And the way to render him to be feared abroad, is to content his people at home, who then with heart and hand are ready to aſſiſt him; and whatſoever God bleſſeth me with, to contribute towards the increaſe of his revenues in any conſiderable way, I deſire it may be employed to the uſe of his people; that is, for the taking off ſuch taxes or burthens from them as they chiefly groan under, and by a temporary neceſſity only impoſed on them; which being thus ſupplied will certainly beſt content the king, and ſatisfie his people; which, I dare ſay, is the continual tend of all your indefatigable pains, and the perfect demonſtrations of your zeal to his Majeſty, and an evidence that the kingdom's truſt is juſtly and deſervedly repoſed in you. And if ever parliament acquitted themſelves thereof, it is this of yours, compoſed of moſt deſerving perſons; qualified, I ſay, with your affection to your prince, and with a tenderneſs to his people; with a bountiful heart towards him, yet a frugality in their behalfs.

Go on, therefore, chearfully, my Lords and Gentlemen, and not only our gracious king, but the King of Kings will reward you, the prayers of the people will attend you, and his Majeſty will with thankful arms, embrace you. And be pleaſed to make uſe of me and my endeavours to enrich them, not myſelf; ſuch being my only requeſt unto you, ſpare me not in what your wiſdoms ſhall find me uſeful,—who do eſteem myſelf, not only by the act of the water-commanding engine, (which ſo chearfully you have paſt) ſufficiently rewarded, but likewiſe with courage enabled to do ten times more for the future; and my debts being paid, and a competency to live according to my birth and quality ſettled, the reſt ſhall I dedicate to the ſervice of our king and country, by your diſpoſals; and eſteem me not the more, or rather any more, by what is paſt, but what is to come; profeſſing really from my heart, that my intentions are to outgo the ſix or ſeven hundred thouſand pounds already ſacrificed, if countenanced and encouraged by you; ingenuouſly confeſſing, that the melancholy which hath lately ſeized upon me (the cauſe whereof none of you but may eaſily gueſs) hath, I dare ſay, retarded more advantages to the public ſervice, than modeſty will permit me to utter: And now revived by your promiſing favours, I ſhall infallibly be enabled thereunto in the experiments extant, and comprized under theſe heads, practicable with my directions, by the unparalleled workman, both for truſt and ſkill, *Caſpar Kaltoff*'s hand, who hath been theſe five and thirty years as in a ſchool under me employed, and ſtill at my diſpoſal, in a place by my great expences made fit for public ſervice, yet lately like to be taken from me, and conſequently from the ſervice of king and kingdom, without the leaſt regard of above ten thouſand pounds expended by me, and through my zeal to the common good;—my zeal, I ſay,—a field large enough for you, my Lords and Gentlemen, to work upon.

The treaſures buried under theſe heads, both for war, peace, and pleaſure, being inexhauſtible; I beſeech you pardon me, if I ſay ſo; it ſeems a vanity, but comprehends a truth; ſince no good ſpring but becomes the more plentiful by how much more it is drawn; and the ſpinner to weave his web is never ſtinted, but further enforced.

The more then that you ſhall be pleaſed to make uſe of my inventions, the more inventive ſhall you ever find me; one invention begetting ſtill another, and more and more improving my ability to ſerve my king and you; and as to my heartineſs therein, there needs no addition,—nor to my readineſs a ſpur. And therefore, my Lords and Gentlemen, be pleaſed to begin, and deſiſt not from commending me till I flag in my obedience and endeavours to ſerve my king and country:

For certainly you'll find me breathleſs firſt
t'expire,
Before my hands grow weary, or my legs do
tire.

Yet abſtracting from any intereſt of my own, but as a fellow ſubject and compatriot will I ever labour in the vineyard, moſt heartily and readily obeying the leaſt ſummons from you, by putting faithfully in execution, what your judgments ſhall think fit to pitch upon amongſt this Century of experiences, perhaps dearly purchaſed by me, but now frankly and *gratis* offered to you. Since my heart, methinks, cannot be ſatisfied in ſerving my king and country, if it ſhould coſt them any thing; as I confeſs when I had the honour to be near ſo obliging a maſter as his late Majeſty, of happy memory, who never refuſed me his ear to any reaſonable motion; and as for unreaſonable ones, or ſuch as were not fitting for him to grant, I would rather to have died a thouſand deaths, than ever to have made any one unto him.

Yet whatever I was ſo happy as to obtain for any deſerving perſon, my pains, breath, and intereſt imployed therein ſatisfied me not, unleſs I likewiſe ſatisfied the fees;—but that was in my golden age.

And even now, though my ability and means are ſhortened, the world knows why my heart remains ſtill the ſame; and be you pleaſed, my Lords and Gentlemen, to reſt moſt aſſured, that the very complacency that I ſhall take in the executing your commands, ſhall be unto me a ſufficient and an abundantly-ſatisfactory reward.

Vouchsafe, therefore, to diſpoſe freely of me, and whatever lieth in my power to perform: Firſt, in order to his Majeſty's ſervice; ſecondly, for the good and advantage of the kingdom; thirdly, to all your ſatisfactions, for particular profit and pleaſure to your individual ſelves; profeſſing, that in all and each of the three reſpects, I will ever demean myſelf as it beſt becomes,

My Lords and Gentlemen,

Your moſt paſſionately-bent Fellow-ſubject in his Majeſty's ſervice, Compatriot for the public good and advantage, and a moſt humble Servant to all and every of you,

WORCESTER.

A

C E N T U R Y

OF THE

Names and Scantlings of INVENTIONS by me already practiſed.

I.

SEVERAL ſorts of ſeals, ſome ſhewing by ſcrues, others by gages, faſtening or unfaſtening all the marks at once; others by additional points and imaginary places, proportional to ordinary eſcocheons and ſeals at arms, and each way palpably and punctually ſetting down (yet private from all others, but the owner, and by his aſſent) the day of the moneth, the day of the week, the moneth of the year, the year of our Lord, the names of the witneſſes, and the individual place where any thing was ſealed, though in ten thouſand ſeveral places, together with the very number of lines contained in a contract, whereby falſification may be diſcovered, and manifeſtly proved, being upon good grounds ſuſpected.

Upon any of theſe ſeals a man may keep accompts of receipts and diſburſements from one farthing to an hundred millions, punctually ſhewing each pound, ſhilling, penny, or farthing.

By theſe ſeals likewiſe any letter, though but written in Engliſh, may be read and underſtood in eight ſeveral languages, and in Engliſh itſelf to clean contrary and different ſenſe, unknown to any but the correſpondent, and not to be read or underſtood by him neither, if opened before it arrive unto him; ſo that neither threats, nor hopes of reward, can make him reveal the ſecret, the letter having been intercepted, and firſt opened by the enemy.

II. How ten thouſand perſons may uſe thoſe ſeals to all and every of the purpoſes aforeſaid, and yet keep their ſecrets from any but whom they pleaſe.

III. A cypher and character ſo contrived, that one line, without returns and circumflexes, ſtands for each and every of the 24 letters; and as ready to be made for the one letter as the other.

IV. This invention refined, and ſo abbreviated, that a point onely ſheweth diſtinctly and ſignificantly any of the 24 letters;

ters; and theſe very points to be made with two pens, ſo that no time will be loſt, but as one finger riſeth the other may make the following letter, never clogging the memory with ſeveral figures for words, and combination of letters; which with eaſe, and void of confuſion, are thus ſpeedily and punctually, letter for letter, ſet down by naked and not multiplied points. And nothing can be leſs than a point, the mathematical definition of being *cujus pars nulla.* And of a motion no ſwifter imaginable than *ſemiquavers* or *reliſhes*, yet applicable to this manner of writing.

V. A WAY by a circular motion, either along a rule or ring-wiſe, to vary any alphabet, even this of points, ſo that the ſelf-ſame point individually placed, without the leaſt additional mark, or variation of place, ſhall ſtand for all the 24 letters, and not for the ſame letter twice in ten ſheets writing; yet as eaſily and certainly read and known as if it ſtood but for one and the ſelf-ſame letter conſtantly ſignified.

VI. HOW at a window, far as eye can diſcover black from white, a man may hold diſcourſe with his correſpondent, without noiſe made or notice taken; being, according to occaſion given and means afforded, *ex re nata*, and no need of proviſion beforehand; though much better if foreſeen, and means prepared for it, and a premeditated courſe taken by mutual conſent of parties.

VII. A WAY to do it by night as well as by day, though as dark as pitch is black.

VIII. A WAY how to level and ſhoot cannon by night as well as by day, and as directly; without a platform or meaſures taken by day, yet by a plain and infallible rule.

IX. AN engine, portable in one's pockets, which may be carried and faſtened on the inſide of the greateſt ſhip, *tanquam aliud agens*, and at any appointed minute, though a week after, either of day or night, it ſhall irrecoverably ſink that ſhip.

X. A WAY, from a mile off, to dive and faſten a like engine to any ſhip, ſo as it may punctually work the ſame effect, either for time or execution.

XI. How to prevent and ſafeguard any ſhip from ſuch an attempt by day or night.

XII. A WAY to make a ſhip not poſſible to be ſunk though ſhot an hundred times betwixt wind and water by cannon, and ſhould ſhe loſe a whole plank, yet in half an hour's time ſhould be made as fit to ſail as before.

XIII. How to make ſuch falſe decks as in a moment ſhould kill and take priſoners as many as ſhould board the ſhip, without blowing the decks up, or deſtroying them from being reducible, and in a quarter of an hour's time ſhould recover their former ſhape, and to be made fit for any employment without diſcovering the ſecret.

XIV. How to bring a force to weigh up an anchor, or to do any forcible exploit in the narroweſt or loweſt room in any ſhip; where few hands ſhall do the work of many; and many hands applicable to the ſame force, ſome ſtanding, others ſitting, and by virtue of their ſeveral helps, a great force augmented in a little room, as effectual as if there were ſufficient ſpace to go about with an axle-tree, and work far from the centre.

XV. A WAY how to make a boat work itſelf againſt wind and tide, yea both without the help of man or beaſt; yet ſo that the wind or tide, though directly oppoſite, ſhall force the ſhip or boat againſt itſelf; and in no point of the compaſs, but it ſhall be as effectual as if the wind were in the pupp, or the ſtream actually with the courſe it is to ſteer, according to which the oars ſhall row, and neceſſary motions work and move towards the deſired port or point of the compaſs.

XVI. How to make a ſea-caſtle or fortification cannon-proof, and capable of a thouſand men, yet ſailable at pleaſure to defend a paſſage, or in an hour's time to divide itſelf into three ſhips as fit and trimm'd to ſail as before: And even whilſt it is a fort or caſtle they ſhall be unanimouſly ſteered, and effectually be driven by an indifferent ſtrong wind.

XVII. How to make upon the Thames a floating garden of pleaſure, with trees, flowers, banqueting-houſes, and fountains, ſtews for all kind of fiſhes, a reſerve for ſnow to keep wine in, delicate bathing places, and the like; with muſic made with mills: and all in the midſt of the ſtream, where it is moſt rapid.

XVIII. An artificial fountain, to be turned like an hour-glaſs by a child in the twinkling of an eye, it holding great quantity of water, and of force ſufficient to make ſnow, ice, and thunder, with a chirping and ſinging of birds, and ſhewing of ſeveral ſhapes and effects uſual to fountains of pleaſure.

XIX. A little engine within a coach, whereby a child may ſtop it, and ſecure all perſons within it, and the coachman himſelf, though the horſes be never ſo unruly in a full career; a child being ſufficiently capable to looſen them in what poſture ſoever they ſhould have put themſelves, turning never ſo ſhort; for a child can do it in the twinkling of an eye.

XX. How to bring up water balancewiſe, ſo that as little weight or force as will turn a balance will be only needful, more than the weight of the water within the buckets, which counterpoiſed empty themſelves one into the other, the uppermoſt yielding its water (how great a quantity ſoever it holds) at the ſelf-ſame time the lowermoſt taketh it in, though it be an hundred fathom high.

XXI. How to raiſe water conſtantly with two buckets only, day and night, without any other force than its own motion, uſing not ſo much as any force, wheel, or ſucker, nor more pullies than one, on which the cord or chain rolleth with a bucket faſtened at each end. This, I confeſs, I have ſeen and learned of the great mathematician *Claudius* his ſtudies at *Rome*, he having made a preſent thereof unto a cardinal; and I deſire not to own any other men's inventions, but if I ſet down any, to nominate likewiſe the inventor.

XXII. To make a river in a garden to ebb and flow conſtantly, though twenty foot over, with a child's force, in ſome private room or place out of ſight, and a competent diſtance from it.

XXIII. To ſet a clock in a caſtle, the water filling the trenches about it; it ſhall ſhew by ebbing and flowing, the hours, minutes, and ſeconds, and all the comprehenſive motions of the heavens, and counterlibation of the earth according to Copernicus.

XXIV. How to increaſe the ſtrength of a Spring to ſuch an height, as to ſhoot bumbaſſes and bullets of an hundred pound weight a ſteeple-height, and a quarter of a mile off and more, ſtonebow-wiſe, admirable for fireworks and aſtoniſhing of beſieged cities, when, without warning given by noiſe, they find themſelves ſo forcibly and dangerouſly ſurpriſed.

XXV. How to make a weight that cannot take up an hundred pound, and yet ſhall take up two hundred pound, and at the ſelf-ſame diſtance from the centre; and ſo proportionably to millions of pounds.

XXVI. To raiſe weight as well, and as forcibly, with the drawing back of the lever, as with the thruſting it forward; and by that means to loſe no time in motion or ſtrength.——This I ſaw in the arſenal at Venice.

XXVII. A WAY to remove to and fro huge weights with a moſt inconſiderable ſtrength, from place to place. For example, ten tunne with ten pounds, and leſs; the ſaid ten pounds not to fall lower than it makes the ten tunne to advance or retreat upon a level.

XXVIII. A BRIDGE, portable in a cart with ſix horſes, which in a few hours time may be placed over a river half a mile broad, whereon may with much expedition be tranſported horſe, foot, and cannon.

XXIX. A PORTABLE fortification, able to contain five hundred fighting men, and yet in ſix hours time may be ſet up, and made cannon-proof, upon the ſide of a river or paſs, with cannon mounted upon it, and as compleat as a regular fortification, and with half-moons and counterſcarps.

XXX. A WAY, in one night's time, to raiſe a bulwark twenty or thirty foot high, cannon-proof, and cannon mounted upon it, with men to overlook, command, and batter a town; for though it contain but four pieces, they ſhall be able to diſcharge two hundred bullets each hour.

XXXI. A WAY how ſafely and ſpeedily to make an approach to a caſtle or town-wall, and over the very ditch, at noon-day.

XXXII. How to compoſe an univerſal character, methodical and eaſy to be written, yet intelligible in any language; ſo that if an *Engliſhman* write it in *Engliſh*, a *Frenchman*, *Italian*, *Spaniard*, *Iriſh*, *Welch*, being ſcholars; yea, *Grecian* or *Hebritian* ſhall as perfectly underſtand it in their own tongue, as if they were perfect *Engliſh*, diſtinguiſhing the verbs from the nouns, the numbers, tenſes, and caſes, as properly expreſſed in their own language, as if it was written in *Engliſh*.

XXXIII. To write with a needle and thread, white, or any colour upon white, or any other colour, ſo that one ſtitch ſhall ſignificantly ſhew any letter, and as readily and as eaſily ſhew the one letter as the other, and fit for any language.

XXXIV. To write by a knotted ſilk ſtring, ſo that every knot ſhall ſignify any letter, with a comma, full-point, or interrogation, and as legible as with pen and ink upon white paper.

XXXV. The like by the fringe of gloves.

XXXVI. By ſtringing of bracelets.

XXXVII. By pinked gloves.

XXXVIII. By holes in the bottom of a ſieve.

XXXIX. By a lattin or plate lanthorn.

XL. By the Smell.

XLI. By the Taſte.

XLII. By the Touch.

By theſe three ſenſes as perfectly, diſtinctly, and unconfuſedly, yea, as readily as by the ſight.

XLIII. How to vary each of theſe, ſo that ten thouſand may know them, and yet keep the underſtanding part from any but their correſpondent.

XLIV. To make a key of a chamber-door, which to your ſight hath its wards and roſe-pipe, but paper-thick, and yet at pleaſure, in a minute of an hour, ſhall become a perfect piſtol, capable to ſhoot through a breſt-plate commonly of carbine-proof, with prime, powder, and firelock, undiſcoverable to a ſtranger's hand.

XLV. How to light a fire and a candle at what hour of the night one awaketh, without riſing or putting one's hand out of bed. And the ſame thing becomes a ſerviceable piſtol at pleaſure; yet by a ſtranger, not knowing the ſecret, ſeemeth but a dexterous tinder-box.

XLVI. How to make an artificial bird to fly which way, and as long as one pleaſeth, by or againſt the wind, ſometimes chirping, other times hovering, ſtill tending the way it is deſigned for.

XLVII. To make a ball of any metal, which thrown into a pool, or pail of water, ſhall preſently riſe from the bottom, and conſtantly ſhew, by the *ſuperficies* of the water, the hour of the day or night, never riſing more out of the water than juſt to the minute it ſheweth of each quarter of the hour; and if by force kept under the water, yet the time is not loſt, but recovered as ſoon as it is permitted to riſe to the *ſuperficies* of the water.

XLVIII. A SCRUED aſcent; inſtead of ſtairs, with fit landing-placces to the beſt chambers of each ſtory, with back-ſtairs within the noell of it, convenient for ſervants to paſs up and down to the inward rooms of them, unſeen and private.

XLIX. A PORTABLE engine, in way of a tobacco-tongs, whereby a man may get over a wall, or get up again being come down, finding the coaſt proving unſecure unto him.

L. A COMPLEAT light, portable ladder, which taken out of one's pocket, may be by himſelf faſtened an hundred foot high to get up by from the ground.

LI. A RULE of gradation, which with eaſe and method reduceth all things to a private correſpondence, moſt uſeful for ſecret intelligence.

LII. How to ſignify words, and a perfect diſcourſe, by jangling of bells of any pariſh church, or by any muſical inſtrument, within hearing, in a ſeeming way of tuning it; or of an unſkilful beginner.

LIII. A WAY how to make and hollow a water-ſcrue as big and as long as one pleaſeth, in an eaſy and cheap way.

LIV. How to make a water-ſcrue tight, and yet tranſparent, and free from breaking; but ſo clear, that one may palpably ſee the water, or any heavy thing, how and why it is mounted by turning.

LV. A DOUBLE water-ſcrue, the innermoſt to mount the water, and the outermoſt for it to deſcend more in number of threads, and conſequently in quantity of water, though much ſhorter than the innermoſt ſcrue, by which the water aſcendeth, a moſt extraordinary help for the turning of the ſcrue to make the water riſe.

LVI. To provide and make that all the weights of the deſcending ſide of a wheel ſhall be perpetually further from the centre than thoſe of the mounting ſide, and yet equal in number and heft to the one ſide as the other. A moſt incredible thing, if not ſeen, but tried before the late king (of bleſſed memory) in the *tower*, by my directions, two extraordinay ambaſſadors accompanying his majeſty, and the duke of *Richmond* and duke *Hamilton*, with moſt of the court attending him. The wheel was 14 foot over, and 40 weights of 50 pounds a-piece. Sir *William Balfore*, then lieutenant of the *tower*, can juſtify it, with ſeveral others. They all ſaw, that no ſooner theſe great weights paſſed the diameter line of the lower ſide, but they hung a foot further from the centre,—nor no ſooner paſſed the diameter-line of the upper ſide, but they hung a foot nearer. Be pleaſed to judge the conſequence.

LVII. An ebbing and flowing water-work, in two veſſels, into either of which, the water ſtanding at a level, if a globe be caſt in, inſtead of riſing it preſently ebbeth, and ſo remaineth until a like globe be caſt into the other veſſel, which the water is no ſooner ſenſible of, but that veſſel preſently ebbeth, and the other floweth, and ſo continueth ebbing and flowing until one or both of the globes be taken out, working ſome little effect beſides its own motion, without the help of any man within ſight or hearing: But if either of theſe globes be taken out with ever ſo ſwift or eaſy a motion, at the very inſtant the ebbing and flowing ceaſeth; for if during the ebbing you take out the globe, the water of that veſſel preſently returneth to flow, and never ebbeth after, until the globe be returned into it, and then the motion beginneth as before.

LVIII. How to make a piſtol diſcharge a dozen times with one loading, and without ſo much as once new priming requiſite, or to change it out of one hand into the other, or ſtop one's horſe.

LIX. Another way, as faſt and effectual, but more proper for carabines.

LX. A way, with a flaſk appropriated unto it, which will furniſh either piſtol or carabine with a dozen charges in three minutes time, to do the whole execution of a dozen ſhots, as ſoon as one pleaſeth, proportionably.

LXI. A third way, and particular for muſkets, without taking them from their reſts to charge or prime, to alike execution, and as faſt as the flaſk, the muſket containing but one charge at a time.

LXII. A way for a harquebuſs, a crock, or ſhip-muſket, ſix upon a carriage, ſhooting with ſuch expedition, as without danger, one may charge, level, and diſcharge them ſixty times in a minute of an hour, two or three together.

LXIII. A sixth way, moſt excellent for ſakers, differing from the other, yet as ſwift.

LXIV. A seventh, tried and approved before the late king, (of ever-bleſſed memory) and an hundred lords and commons, in a cannon of 8 inches, half quarter, to ſhoot bullets of 64 pounds weight, and 24 pounds of powder, twenty times in ſix minutes; ſo clear from danger, that after all were diſcharged, a pound of butter did not melt, being laid upon the cannon britch, nor the green oil diſcoloured that was firſt anointed and uſed between the barrel thereof, and the engine, having never in it, nor within ſix foot, but one charge at a time.

LXV. A way that one man in the cabin may govern the whole ſide of ſhip-muſquets to the number (if need require) of 2 or 3000 ſhots.

LXVI. A way that againſt ſeveral avenues to a fort or caſtle, one man may charge fifty cannons, playing and ſtopping when he pleaſeth, though out of ſight of the cannon.

LXVII. A rare way likewiſe for muſquetoons faſtened to the pummel of the ſaddle, ſo that a common trooper cannot miſs to charge them, with twenty or thirty bullets at a time, even in full career.

When firſt I gave my thoughts to make guns ſhoot often, I thought there had been but one onely exquiſite way inventible, yet by ſeveral trials, and much charge, I have perfectly tried all theſe.

LXVIII. An admirable and moſt forcible way to drive up water by fire, not by drawing or ſucking it up upwards, for that muſt be, as the philoſopher calleth it, *intra ſphæram activitatis*, which is but at ſuch a diſtance. But this way hath no bounder, if the veſſels be ſtrong enough; for I have taken a piece of a whole cannon, whereof the end was burſt, and filled it three quarters full of water, ſtopping and ſcruing up the broken end, as alſo the touch-hole; and making a conſtant fire under it, within 24 hours it burſt and made a great crack: So that having a way to make my veſſels, ſo that they are ſtrengthened by the force within them, and the one to fill after the other. I have ſeen the water run like a conſtant fountaine-ſtream forty foot high, one veſſel of water rarified by fire driveth up forty of cold water. And a man that tends the work is but to turn two cocks, that one veſſel of water being conſumed, another begins to force and re-fill with cold water, and ſo ſucceſſively, the fire being tended and kept conſtant, which the ſelf-ſame perſon may likewiſe abundantly perform in the interim between the neceſſity of turning the ſaid cocks.

LXIX. A way how a little triangle ſcrued key, not weighing a ſhilling, ſhall be capable and ſtrong enough to bolt and unbolt round about a great cheſt, an hundred bolts through fifty ſtaples, two in each, with a direct contrary motion, and as many more from both ſides and ends, and at the ſelf-ſame time ſhall faſten it to a place beyond a man's natural ſtrength to take it away; and in one and the ſame turn both locketh and openeth it.

LXX. A KEY with a roſe-turning pipe, and two roſes pierced through endwiſe the bit thereof, with ſeveral handſomly contrived wards, which may likewiſe do the ſame effects.

LXXI. A KEY perfectly ſquare, with a ſcrue turning within it, and more conceited than any of the reſt, and no heavier than the triangle ſcrued key, and doth the ſame effects.

LXXII. AN eſcocheon to be placed before any of theſe locks, with theſe properties:

1. THE owner (though a woman) may, with her delicate hand, vary the ways of coming to open the lock ten millions of times, beyond the knowledge of the ſmith that made it, or of me who invented it.

2. If a ſtranger open it, it ſetteth an alarm a-going, which the ſtranger cannot ſtop from running out; and beſides, though none ſhould be within hearing, yet it catcheth his hand, as a trap doth a fox; and though far from maiming him, yet it leaveth ſuch a mark behind it, as will diſcover him if ſuſpected; the eſcocheon or lock plainly ſhewing what monies he hath taken out of the box to a farthing, and how many times opened ſince the owner had been in it.

LXXIII. A tranſmittable gallery over any ditch or breach in a town-wall, with blind and parapet cannon-proof.

LXXIV. A door, whereof the turning of a key, with the help and motion of the handle, makes the hinges to be of either ſide, and to open either inward or outward, as one is to enter or to go out, or to open in half.

LXXV. How a tape or ribbon-weaver may ſet down a whole diſcourſe, without knowing a letter, or interweaving any thing ſuſpicious of other ſecret than a new-faſhioned ribbon.

LXXVI. How to write in the dark as ſtreight as by day or candle-light.

LXXVII. How to make a man fly; which I have tried with a little boy of ten years old, in a barn, from one end to the other, on a hay-mow.

LXXVIII. A WATCH to go conſtantly, and yet needs no other winding from the firſt ſetting on the cord or chain, unleſs it be broken, requiring no other care from one than to be now and then conſulted with concerning the hour of the day or night; and if it be laid by a week together, it will not erre much, but the oftener looked upon, the more exact it ſheweth the time of the day or night.

LXXIX. A WAY to lock all the boxes of a cabinet (though never ſo many) at one time, which were by particular keys appropriated to each lock, opened ſeverally, and independent the one of the other, as much as concerneth the opening of them, and by theſe means cannot be left opened unawares.

LXXX. How to make a piſtol barrel no thicker than a ſhilling, and yet able to endure a muſquet-proof of powder and bullet.

LXXXI. A combe-conveyance carrying of letters without ſuſpicion, the head being opened with a needle-ſcrue, drawing a ſpring towards them; the comb being made but after an uſual form carried in one's pocket.

LXXXII. A knife-ſpoon or fork, in an uſual portable caſe, may have the like conveyances in their handles.

LXXXIII. A raſping-mill for harts-horn, whereby a child may do the work of half a dozen men, commonly taken up with that work.

LXXXIV. An inſtrument whereby perſons ignorant in arithmetic may perfectly obſerve numeration and ſubſtractions of all ſums and fractions.

LXXXV. A little ball made in the ſhape of plumb or pear, being dexterouſly conveyed or forced into a body's mouth, ſhall preſently ſhoot forth ſuch and ſo many bolts of each ſide, and at both ends, as without the owner's key can neither be opened or filed off, being made of tempered ſteel, and as effectually locked as an iron-cheſt.

LXXXVI. A chair made *a-la-mode*, and yet a ſtranger being perſuaded to ſit down in't, ſhall have immediately his arms and thighs locked up beyond his own power to looſen them.

LXXXVII. A BRASS mold to caſt candles, in which a man may make 500 dozen in a day, and add an ingredient to the tallow which will make it cheaper, and yet ſo that the candles ſhall look whiter, and laſt longer.

LXXXVIII. How to make a brazen or ſtone head, in the midſt of a great field or garden, ſo artificial and natural, that though a man ſpeak never ſo ſoftly, and even whiſpers in the ear thereof, it will preſently open its mouth, and reſolve the queſtion in *French*, *Latin*, *Welſh*, *Iriſh*, or *Engliſh*, in good terms uttering it out of his mouth, and then ſhut it until the next queſtion be aſked.

LXXXIX. WHITE ſilk knotted in the fingers of a pair of white gloves, and ſo contrived without ſuſpicion, that playing at *primero* at cards, one may, without clogging his memory, keep reckoning of all ſixes, ſevens, and aces, which he hath diſcarded.

XC. A MOST dextereous dicing box, with holes tranſparent, after the uſual faſhion, with a device ſo dexterous, that with a knock of it againſt the table the four good dice are faſtened, and it looſeneth four falſe dice made fit for his purpoſe.

XCI. AN artificial horſe, with ſaddle, and caparifons fit for running at the ring, on which a man being mounted, with his lance in his hand, he can at pleaſure make him ſtart, and ſwiftly to run his career, uſing the decent poſture with *bon grace*, may take the ring as hanſomely, and running as ſwiftly as if he rode upon a barbe.

XCII. A SCRUE made like a water-ſcrue, but the bottom made of iron-plate, ſpade-wiſe, which at the ſide of a boat emptieth the mud of a pond, or raiſeth the gravel.

XCIII. AN engine whereby one man may take out of the water a ſhip of 500 tun, ſo that it may be calked, trimmed, and repaired, without need of the uſual way of ſtocks, and as eaſily let it down again.

XCIV. A LITTLE engine, portable in one's pocket, which placed to any door, without any noiſe but one crack, openeth any door or gate.

XCV. A DOUBLE croſs-bow, neat, handſome, and ſtrong, to ſhoot two arrows, either together or one after the other, ſo immediately that a deer cannot run two ſteps but if he miſs of one arrow, he may be reached with the other, whether the deer run forward, ſideward, or ſtart backward.

XCVI. A WAY to make a ſea bank ſo firm and geometrically ſtrong, that a ſtream can have no power over it; excellent likewiſe to ſave the pillar of a bridge, being far cheaper than ſtone walls.

XCVII. AN inſtrument whereby an ignorant perſon may take any thing in perſpective, as juſtly, and more than the ſkilfulleſt painter can do by his eye.

XCVIII. AN engine, ſo contrived, that working the *primum mobile* forward or backward, upward or downward, circularly or cornerwiſe, to and fro, ſtreight, upright or downright, yet the pretended operation continueth, and advanceth, none of the motions above-mentioned, hindering, much leſs ſtopping the others; but unanimouſly, and with harmony agreeing, they all augment and contribute ſtrength unto the intended work and operation: And therefore I call this a *ſemi-omnipotent engine*, and do intend that a model thereof be buried with me.

XCIX. HOW to make one pound weight to raiſe an hundred as high as one pound falleth, and yet the hundred pound deſcending doth what nothing leſs than one hundred pound can effect.

C. Upon ſo potent a help as theſe two laſt mentioned inventions, a water-work is, by many years experience and labour, ſo advantageouſly by me contrived, that a child's force bringeth up an hundred foot high an incredible quantity of water, even two foot diameter, ſo naturally, that the work will not be heard into the next room; and with ſo great eaſe and geometrical ſymmetry, that though it work day and night from one end of the year to the other, it will not require forty ſhillings reparation to the whole engine, nor hinder ones day work. And I may boldly call it *The moſt ſtupendious work in the whole world:* Not only with little charge to drain all ſorts of mines, and furniſh cities with water, though never ſo high ſeated, as well to keep them ſweet, running through ſeveral ſtreets, and ſo performing the work of ſcavengers, as well as furniſhing the inhabitants with ſufficient water for their private occaſions; but likewiſe ſupplying rivers with ſufficient to maintaine and make them portable from town to town, and for the bettering of lands all the way it runs; with many more advantageous, and yet greater effects of profit, admiration, and conſequence. So that deſervedly I deem this invention to crown my labours, to reward my expences, and make my thoughts acquieſce in way of further inventions: This making up the whole century,

tury, and preventing any further trouble to the reader for the preſent, meaning to leave to poſterity a book, wherein under each of theſe heads the means to put in execution and viſible trial all and every of theſe inventions, with the ſhape and form of all things belonging to them, ſhall be printed by braſs plates.

In Bonum Publicum,

E T

Ad majorem DEI *Gloriam.*

* * *

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F I N I S.

APPENDIX:

CONTAINING AN

Hiſtorical Account

OF THE

FIRE-ENGINE

FOR

Raiſing WATER.

APPENDIX, &c.

THAT the great force of ſteam was known to the antients, appears from VITRUVIUS, who in his *Architect. Lib*. I. *Cap*. 6. teaches “ *parvulo æolipilæ ſpectaculo de immanibus ventorum naturæ rationibus judicari poſſe cenſuit*.” But the firſt, I think, who endeavoured to bring this matter to the teſt of experiment, was our countryman, the great Lord VERULAM, who, in a work entitled *Impetus Philoſophici*, col. 705, records the following experiment :—

“ *Sum ſit phialam vitream, quæ fortaſſe unciam unam capiebat, cujus collum labro latiore reverſo erat inſtructum, eamque dimidiam aqua replevit, et pondus ejus et aquæ contentæ bilance expendit, dein veſicam, quæ circiter pintam continebat, recentem, oleoque bene obturatam, ad os phialæ filo cerato fortiter alligavit, et phialam ſuper carbones candentes collocavit ; aqua non ita multo poſt bullire cæpit, et paulatim veſicam* *ex omni parte ſufflavit, fereque ad rupturam extendit, quod cum fieret, ſtatim vitrum ab igne remotum et ſuper tapetum poſitum fuit, ne repentino frigore diſrumperetur; tum in ſummo veſicæ acu foramen aperuit, per quod vapor ſubito erumpebat. Poſtea veſicam prorſus a phiala removit, et ejus iterum pondus quæſivit, reperitque duorum denariorum pondus aquam amaſiſſe inde collegit, vaporem, qui veſicam implebat, denariorum duorum ponderi æquipollere, ipſumque vaporum aquæ ad corpus aquæ rationem octogecuplam habuiſſe.*"

Now, although the above related experiment was ſo circumſtanced as to afford no very accurate reſult, either with reſpect to the quantity of water thrown off in ſteam, or the expanſive force of the ſteam generated; yet it is highly probable that it might be, in ſome degree, productive of one of the moſt lucky thoughts that ever entered the human mind:—I mean that thought of raiſing water by the *force of ſteam*; which undoubtedly occurred firſt to that moſt ingenious nobleman the MARQUIS OF WORCESTER.

THIS ſuggeſtion will appear the more reaſonable when we conſider, that the ſage experimenter, the great LORD VERULAM, (after having laid the moſt permanent foundations for philoſophical experiments) died 1626; which was only 29 years prior to 1655, when, the Marquis tells us, he had acquired a knowledge of all the inventions contained in his work; and that, conſequently, there can be no doubt of the Marquis having read his Lordſhip's works, which, at that time, would moſt certainly make a great deal of noiſe in the world, and be of a *caſt* entirely compatible with the bent of the Marquis's genius.

As the date of the *Century of Inventions*, &c. leaves no room to doubt of the Marquis being the only perſon to whom poſterity ſtands indebted for the *original hint* of the Fire-Engine,—we ſhall therefore proceed to give ſuch accounts thereof as the beſt authors furniſh us with; and firſt, we ſhall tranſcribe *Switzer*'s account, as given in his Hydroſt. and Hydraul. printed at *London* in 1729.

MR STEPHEN SWITZER'S *Account of the Invention of the* FIRE-ENGINE; *from his* Hydroſt. *and* Hydraul. *Vol.* II. *p.* 325.

"AMONGST the ſeveral engines which have been contrived for the raiſing of water for the ſupply of houſes and gardens, none has been more juſtly ſurpriſing than that of raiſing water by fire; the particular contrivance, and ſole invention of a gentleman, with whom I had the honour long ſince to be well acquainted; I mean the ingenious Captain *Savery*, ſome time ſince deceaſed, but then a moſt noted engineer, and one of the commiſſioners of the ſick and wounded.

"THIS gentleman's thoughts (as appears by a preface of his to a little book, entitled *The Miner's Friend*) were always employed in hydroſtatics or hydraulics, or in the improvement of water-works; and the firſt hint from which it is ſaid he took this engine, was from a *tobacco pipe*, which he immerſed to waſh or cool it, as is ſometimes done; he diſcovered by the rarefaction of the air in the tube, by the heac or ſteam of the water and the gravitation or impulſe of the exterior air, that the water was made to ſpring through the tube of the pipe in a wonderful, ſurpriſing manner; tho' others ſay, that the learned Marquis of *Worceſter*, in his *Century of Inventions*, (which book I have not ſeen) *ſee Obſ.* 68, gave the firſt hint for this raiſing water by fire.

"IT was a conſiderable time before this curious perſon, who has been ſo great an honour to his country, could (as he himſelf tells us) bring this deſign to perfection, on account of the auckwardneſs of the workmen, who were neceſſarily to be employed in the affair; but at laſt he conquered all difficulties, and procured a recommendation of it from the Royal Society, in *Tranſact.* No. 252, and ſoon after a patent from the crown, for the ſole making this engine; and I have heard him ſay myſelf, that the very firſt time he played it, was in a potter's houſe at *Lambeth*, where, tho' it was a ſmall engine, yet it forced its way through the roof, and ſtruck up the tiles in a manner that ſurpriſed all the ſpectators.

"About the year 1699, he wrote a ſmall pamphlet or treatiſe concerning this engine which I have juſt now mentioned; wherein he has exhibited a draught of it, as alſo a particular deſcription of its uſes."

Next follows Dr *Deſagulier*'s Account, from his Courſe of *Experimental Philoſophy:* —*London*, printed 1744.

"In the latter end of King *Charles* the Second's reign, the Marquis of *Worceſter* publiſhed a book, called *A Century of Inventions*, (printed at *London* in 1663) which he deſcribed, as having already put ſome of them in execution, and propoſing others as practicable and beneficial; for which he wanted encouragement from the legiſlature. Several were only hints, and ſome things he was miſtaken in; but one of his propoſals in which he is moſt explicit, is that of raiſing water by the force of fire, turning water into ſteam to preſs up great quantities of cold water. The words of the Marquis, No. 68, are as follow:

"*An admirable and moſt forcible way to drive up water by fire, not by drawing or ſucking it upwards, for that muſt be as the philoſopher calleth it,* intra ſphæram activitatis, *which is but at ſuch a diſtance. But this way hath no bounder if the veſſels be ſtrong enough; for I have taken a piece of a whole cannon, whereof the end was burſt, and filled it three quarters full of water, ſtopping and ſcruing up the broken end, as alſo the touch-hole; and making a conſtant fire under it, within* 24 *hours it burſt and made a great crack: So that having a way to make my veſſels, ſo that they are ſtrengthened by the force within them, and the one to fill after the other. I have ſeen the water run like a conſtant fountaine-ſtream forty foot high, one veſſel of water rarified by fire driveth up forty of cold water. And a man that tends the work is but to turn two cocks, that one veſſel of water being conſumed, another begins to force and re-fill with cold water, and ſo ſucceſſively, the fire being tended and kept conſtant, which the ſelf-ſame perſon may likewiſe abundantly perform in the interim between the neceſſity of turning the ſaid cocks.*"

" CAPT. SAVERY, having read the Marquis of *Worceſter's* book, was the firſt who put in practice the raiſing water by fire, which he propoſed for the draining of mines. His engine is deſcribed in *Harris's* Lexicon, (ſee the word ENGINE) which being compared with the Marquis of *Worceſter's* deſcription, will eaſily appear to have been taken from him; though Captain *Savery* denied it, and the better to conceal the matter, bought up all the Marquis of *Worceſter's* books that he could purchaſe in *Pater-noſter-row*, and elſewhere, and burn'd 'em in the preſence of the gentleman, his friend, who told me this. He ſaid that he found out the power of ſteam by chance, and invented the following ſtory to perſuade the people to believe it, viz. That having drank a flaſk of *Florence* at a tavern, and thrown the empty flaſk upon the fire, he called for a baſon of water to waſh his hands, and perceiving that the little wine left in the flaſk had filled up the flaſk with ſteam, he took the flaſk by the neck, and plunged the mouth of it under the ſurface of the water in the baſon, and the water of the baſon was immediately driven up into the flaſk by the preſſure of the air. Now he never made ſuch an experiment then, nor deſignedly afterwards, which I thus prove:

“ I MADE the experiment purpoſely with about half a glaſs of wine left in a flaſk, which I laid upon the fire till it boiled into ſteam; then putting on a thick glove to prevent the neck of the flaſk from burning me, I plunged the mouth of the flaſk under the water that filled a baſon; but the preſſure of the atmoſphere was ſo ſtrong, that it beat the flaſk out of my hand with violence, and threw it up to the cieling. As this muſt alſo have happened to Captain *Savery*, if ever he had made the experiment, he would not have failed to have told ſuch a remarkable incident which would have embelliſhed his ſtory.

“ CAPTAIN SAVERY made a great many experiments to bring this machine to perfection, and did erect ſeveral, which raiſed water very well for gentlemen's ſeats; but could not ſucceed for mines, or ſupplying towns, where the water was to be raiſed very high and in great quantities; for then the ſteam required being boiled up to ſuch a ſtrength, as to be ready to tear all the veſſels to pieces. The heat which is ſufficient to boil water will produce ſteam whoſe ſpring is of the ſame ſtrength as common air; but that ſteam by the removal of the atmoſphere and letting it return to preſs, is only capable of bringing the water up to a little above 30 foot; but for every 32 foot that the water is to be raiſed higher, the ſteam muſt be ſo many times ſtronger than the air: For example, if it is to be forced up 90 or 100 foot higher than the receivers, where the ſteam acts upon it, the ſteam muſt be three or four times ſtronger than the common air; and a great deal ſtronger than that (perhaps ſix times ſtronger) upon the following account: The hot ſteam ſtriking upon the ſurface of cold water in the receivers, condenſes itſelf, and thereby becomes uneffectual, till the ſurface of the water and a ſmall depth of it is warm enough not to condenſe any more ſteam; and then (and not before) the water yields to the preſſure of the ſpring of the ſteam to make it riſe. I have known Captain *Savery* at *York*-buildings, make ſteam eight or ten times ſtronger than common air; and then its heat was ſo great, that it would melt common ſoft ſolder; and its ſtrength ſo great as to blow open ſeveral of the joints of his machine: ſo that he was forced to be at the pains and charge to have all his joints ſoldered with ſpelter or hard ſolder.

" THESE diſcouragements ſtopped the progreſs and improvement of this engine, till Mr *Newcomen*, an ironmonger, and *John Cawley*, a glazier, living at *Dartmouth*, brought it to the preſent form in which it is now uſed, and has been near theſe 30 years.

"Tho' his method differs much from Captain *Savery*'s, and the force of the engine is quite different; yet it is wrought by the ſame power, viz. the expanſion of water into ſteam; and that power is raiſed by fire."

From the Annotations to his 12th Lecture.

A more particular Account of the Inventors or Improvers of the ſeveral Parts of the Fire-Engine.

"About the year 1710, *Thomas Newcomen*, ironmonger, and *John Calley*, glazier, of *Dartmouth*, in the county of *Southampton*, (*Anabaptiſts*) made then ſeveral experiments in private, and having brought it to work with a piſton, &c. in the latter end of the year 1711, made propoſals to draw the water at *Griff*, in *Warwickſhire*; but their invention meeting not with reception, in *March* following, thro' the acquaintance of Mr *Potter*, of *Broomſgrove*, in *Worceſterſhire*, they bargained to draw water for Mr *Back* of *Wolverhampton*, where, after a great many laborious attempts, they did make the engine work; but not being either philoſophers to underſtand the reaſons, or mathematicians enough to calculate the powers, and to proportion the parts, very luckily by accident found what they ſought for. They were at a loſs about the pumps, but being ſo near *Birmingham*, and having the aſſiſtance of ſo many admirable and ingenious workmen, they ſoon came to the method of making the pump-valves, clacks, and buckets; whereas they had but an imperfect notion of them before. One thing is very remarkable; as they at firſt were working, they were ſurpriſed to ſee the engine go ſeveral ſtrokes, and very quick together, when after a ſearch they found a hole in the piſton, which let the cold water in to condenſe the ſteam in the inſide of the cylinder, whereas before they had always done it on the outſide. They uſed before to work with a buoy in the cylinder incloſed in a pipe, which buoy roſe when the ſteam was ſtrong, and opened the injection, and made a ſtroke; thereby they were capable of only giving ſix, eight, or ten ſtrokes in a minute, 'till a boy, *Humphrey Potter*, who attended the engine, added (what he called *Scoggan*) a catch, that a beam (now called the *Working Plug*) always opened; and then it would go fifteen or ſixteen ſtrokes in a minute.

" But this being perplexed with catches and ſtrings, Mr *Henry Beighton*, in an engine he had built at *Newcaſtle on Tyne*, in 1718, took them all away, the beam itſelf ſimply ſupplying all much better.—N. B. About the year 1717, *I communicated to Mr* Henry Beighton, *the uſe of the ſteel-yard over the* PUPPET CLACK, *or ſafety-valve, which he applied to ſome engines.*

“ THE way of leathering the piſton was found by accident about 1713; having then ſcrewed a large broad piece of leather to the piſton, which turned up the ſides of the cylinder two or three inches; in working it wore through, and cut that piece from the other, which falling flat on the piſton, wrought with its edge to the cylinder, and having been in a long time, was worn very narrow; which being taken out they had the happy diſcovery, whereby they found that a bridle rein, or even a ſoft thick piece of rope or match going round, would make the piſton air and water-tight.

MR *Beighton*'s account of an experiment which he made on the fire-engine, to know what quantity of ſteam a cubical inch of water produces, which I thought very well worth mentioning here.

“ I FOUND by ſeveral experiments by a
“ divided ſteel-yard on the puppet or ſafe-
“ ty-valve on the top of the boilers, at
“ *Griff* and *Waſſington*, that when the elaſti-
“ city

“ city of ſteam was juſt one pound avoirdupoids
“ on a ſquare inch, it was ſufficient
“ to work the engine, and that about five
“ pints in a minute would feed the boiler
“ as faſt as it conſumed in boiling and
“ ſteam for the cylinder, 16 ſtrokes in a
“ minute. *Griff* cylinder held 113 gallons
“ of ſteam every ſtroke, × by 16 ſtrokes
“ in a minute, = 1808 ale gallons; ſo five
“ pints of water produced 1808 gallons of
“ ſteam, 38.2 cubic inches in one pint.
“ Then 38.2 inches : 1808 gallons :: 1
“ inch : 47 gallons 3-10ths: Hence it appears
“ 1 cubic inch of water by boiling
“ till its elaſticity is capable of overcoming
“ about $\frac{1}{15}$ of the atmoſphere, will make
“ 13,338 cubic inches of ſteam.

“ By experiment I have found that out
“ of the eduction-valve of a 32 inch cylinder,
“ there comes out 1 gallon each ſtroke;
“ it is ſurpriſing how that ſteam, which is
“ made of about 3 cubic inches of water,
“ ſhould heat 1 gallon of cold water, ſo as
“ to have it come out ſcalding hot, which
“ it does, and the cylinder in all its upper
“ part is but warm when the piſton is
“ down.”

N. B. There ſeems to be an error in the above number of 38.2 cubic inches in a pint, it certainly ſhould be $35\frac{1}{4}$; which I thought proper enough to mention here.

The above quotations, on account of the period of time at which they were written, give the beſt hiſtorical account of the Fire-Engine now to be met with, notwithſtanding they differ in ſome circumſtances; and all the other accounts that I have ſeen are only mutilations thereof; for which reaſon I choſe to give them in the words of their own reſpective authors.

Much about the ſame period of time that Captain *Savery* was going forward with his engine in *England*, *M. Papin*, M. D. and Profeſſor of Mathematics, at *Marbourg*, was in hands with a ſimilar invention; for in the preface to a ſmall work entitled, *Nouvelle maniere d'elever l'Eau par la Force du Feu*, printed at *Caſſel* in 1707, he relates, that he had in the year 1698 made a great number of experiments, by order of his *A. S. Charles Landgrave*, of *Heſſe*, for *Raiſing Water by the Force of Fire*; and which he had communicated to many people, and among them to *M. Leibnitz*, who informed him that he had alſo had the ſame thought.

Now although *M. Papin* arrogates to himſelf the honour of having firſt made experiments on this ſubject, yet he does not ſay how, nor with whom the *lucky thought* originated; but acknowledges, that as a ſimilar idea might have occurred to Captain *Sa-*

Savery, as well as to others, he ought alſo to be eſteemed as one of the firſt inventors. *Monſ. Papin* afterwards tells us, that he only wants to inform the world that the ſaid *Landgrave of Heſſe* was the firſt perſon who had formed ſo uſeful a deſign, and by whoſe order the firſt experiments on that ſubject were made.

WHILST *Monſ. Papin* laboured in *Germany*, and *Captain Savery* in *England*, in bringing the action of fire into uſe in the movement of machines, *Monſ. Amontons* was alſo engaged on the ſame ſubject in *France*; as if the three nations in *Europe*, who had already made the greateſt progreſs in the ſciences, had each furniſhed a learned man to participate in the glory of ſo important a diſcovery.

THE deſign of *Monſ. Amontons* was a fire-wheel, (*moulin à feu*) a draught of which, with its deſcription, may be ſeen in the *Memoires de l'Académie Royale des Sciences, année* 1699. But dying ſoon after, the world was deprived of ſeeing his deſign reduced to practice.

AS the machines of *Monſ. Papin* were, in management and effect, in no degree comparable with thoſe of *Captain Savery*, and as very little was done on the ſubject by *Monſ.*

Amontons, the *Engliſh* nation is undoubtedly entitled to the honour of this moſt happy diſcovery; and I ſhall conclude with a tranſlation of *Monſ. Belidor's* account of this matter, from his ARCHITEC. HYDRAUL. *Tome* II. *Livre* IV. *Chap.* III. "Although the *Marquis of Worceſter* was the firſt in *England* who mentioned, in intelligible terms, a machine for raiſing water by means of fire, in a ſmall tract, entitled A CENTURY OF INVENTIONS; yet we cannot diſpute *Captain Savery* to have been the firſt who executed theſe ſorts of machines in *Great-Britain*; as is atteſted by many letters wrote to me, on that occaſion, by the gentlemen of the Royal Society there; in one of which mention is alſo made of Mr *Newcomen's* having contributed very much to bring it to its preſent perfection. Another proof that this machine took birth in *England*, and that it excels every thing of the kind that hath been tried in *France* and *Germany*, is, that all the fire-engines that have been conſtructed abroad, have been executed by *Engliſhmen*."——Thanks to *Monſ. Belidor*, for his impartiality; few foreigners ever giving any applauſe to our nation, if there was the leaſt reaſon for arrogating it to their own.

FINIS.

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F I N I S.

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